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# Application Engineered Cement Composite Material to Building Fire Resistance at Coastal Area

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***Abstract-***When building from concrete material on fire for long time, can make damage the material. The degree of damage depended of degree of temperature and duration of fire. This research use Engineered cement composite material to compare with concrete material for building fire resistance. This research assumed to find out the change of Engineered cement composite strength, modulus of rupture and shear strength pre and post burn. Temperature fire was 600 $^0$c at duration 3 hours with two variation mix design of Engineered Cement composite. The results showed that the ECC was decrease of compressive strength, MOR, and shear after burn. Variation one with result K 400 decrease 19%, 23% and 45,61% for compressive strength, modulus of rupture and shear strength. Variation two with result K 350 decrease 20%, 27,2% and 60% for compressive strength, modulus of rupture and shear strength.

***Keyword:*** Concrete; Post-Burn; ECC (Engineered Cement Composite); Experimental

## 1. Introduction

When concrete material on fire for long time, can make concrete damage The degree of damage depended of degree of temperature and duration of fire. Effect of fire can make changes in strength, stiffness, stability and resistance to environmental conditions where concrete structures damaged by burning at high temperatures will decrease due to the disintegration of the power of C-S-H. Engineered cement composite material Use in this research because this concrete material have ability to repair themselves in case in small crack (self healing concrete).

Engineered Cement Composites (ECC) is high performance fiber reinforced cementitious composites, featuring high ductility and medium fiber content. Material engineering of ECC is constructed on the paradigm of the relationships between material microstructures, processing, material properties, and performance, where micromechanics is highlighted as the unifying link between composite mechanical performance and material microstructure properties [1]

This paper presents an experimental investigation to compare Engineered cement composite with concrete material. The effects of various parameters have been investigated. These parameters are concrete compressive strength, Split tensile strength, flexural strength and shear test. these variables will be known behavior of the mechanical properties of the material ECC (Engineered Cement Composite) both pre- and post-burn. These properties have been analyzed and resulted in a decrease in capacity models ECC (Engineered Cement Composite) post-combustion.

## 2. Experimental Program

The test specimen consists of a cylindrical test specimen with a diameter of 15 cm, height 30 cm, beam-shaped specimen with a size of 15 cm x 15 cm x 60 cm, the shear test object with a size of 6 cm x 15 cm x 35 cm, for the pre-testing and post-burn. The total number of test specimens tested were as many as 36 pieces of objects for cylindrical objects, 12 concrete beam-shaped test specimens and 12 test objects shaped shear beam .. The test specimen consists of two variations with each variation of as much

as 3 specimens. The specimen tested pre and post burn to determine the mechanical properties. Temperature of Fire was 6000C at duration 3 hours. Before test The specimen was allowed to stand for 24 hours after burn. The specimen was tested after the age of 90 days. **Table 2** gives the specimen detail

Two different concrete mix of engineered cement composite (ECC) where design 35 MPa (K350) and 40 MPa (K400), the variation of mix design use Victor C, Li design [2]. Polyvinyl Alcohol (PVA) fiber use in this experiment. **Table 1** gives mix design detail.

Table 1. Mix design Detail

| No | Parameter | K400 (var 1) | K350 (var2) |
|---|---|---|---|
| 1. | Cement | 1 | 1 |
| 2. | Fly ash | 1,2 | 2,2 |
| 3. | Silica Sand | 0,8 | 2,2 |
| 4. | Water | 0,51 | 0,91 |
| 5. | Superplastizer | 0,014 | 0,018 |
| 6. | Fiber PVA (vol %) | 0,02 | 0.02 |

Table 2. Specimen Detail

| No | Parameters | Pre burn | Post burn | Variation concrete | Specimen test |
|---|---|---|---|---|---|
| 1. | Concrete compressive strength | 9 | 3 | 2 | cylinder |
| 2. | Split tensile strength | 3 | 3 | 2 | cylinder |
| 3. | Flexural strength | 3 | 3 | 2 | beam |
| 4. | Shear test | 3 | 3 | 2 | beam |

## 3. Experimental Result

### 3.1 Temperature Graphic

The combustion process of the test specimen in accordance with ASTM E 119-95a regulation is "Standard test methods for fire tests of building construction and materials".

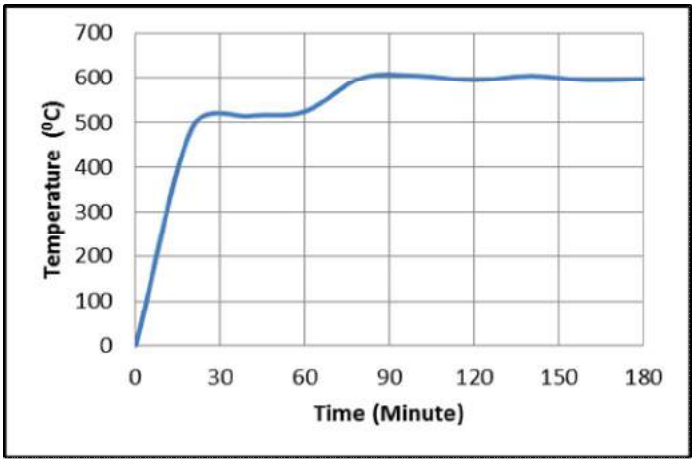

Figure. 1 Temperature process

from the graph can be seen that at the time the first 50 minutes of the course of combustion furnace temperature decreased slightly, it is because there are problems on the burner, but this does not last long, when compared with the regulations ASTM E 119-95a, then the temperature increase is appropriate.

### 3.2 Compressive Strength Test

Concrete compressive strength was testing pre- and post-burn. the specimen for pre-combustion was test at age of concrete 7, 14, 28 days. Specimen post-combustion concrete was burn after the age of specimen 90 days and was testing Concrete compressive strength, 24 hours after the combustion process. The result compressive test pre burn at **table 3** and **figure. 2**

Table 3 Compressive strength Test pre burn

| Parameter | Age (days) (kg/cm2) | | | Specimen test |
|---|---|---|---|---|
| | 7 | 14 | 28 | |
| K400 (var 1) | 201,93 | 272,71 | 332,15 | Cylinder |
| K350 (var 2) | 118,90 | 157,58 | 308,00 | Cylinder |

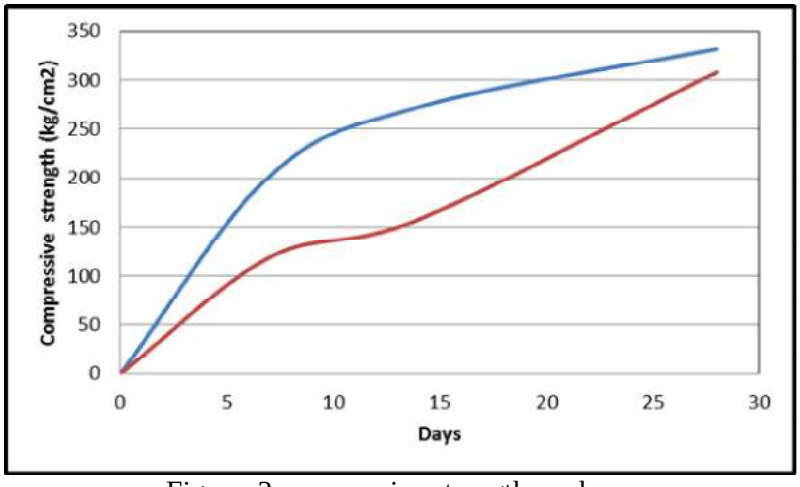

Figure. 2 compressive strength pre burn

Specimen pre burn at compressive concrete test, The specimen does not appear damaged, although the concrete compressive tool shows there has been a decrease in compressive force, This condition show that Engineered cement composite (ECC) have ability to repair themselves in case in small crack (self healing concrete)

The results of the compressive strength of the pre and post-burn compared to the variation 2 (K350) and variation 1 (K400) can show at **Figure 3**. From Figure can be show that var 2(K350) was degradation 19,37% and var 1(k400) 18,19%

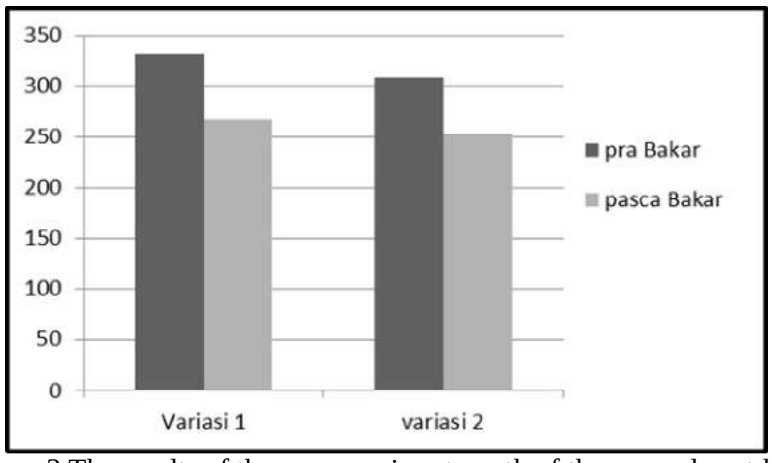


Figure. 3 The results of the compressive strength of the pre and post-burn

Engineered Cement composite material was compare with concrete material can be show at figure. 4. Concrete material use from research of Trisni et al [3], the result show that Engineered cement composite more better than concrete material.

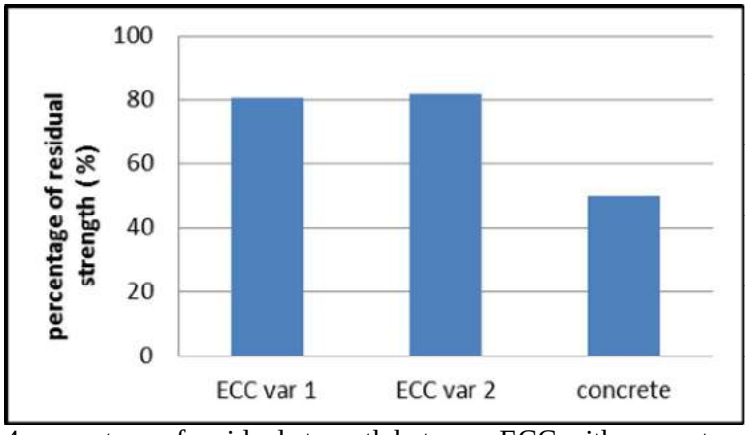


Figure 4 percentage of residual strength between ECC with concrete material

### 3.3 Tensile Strength Test

Testing the tensile strength divided by the split cylinder test in ASTM C496-90, the result show that Variation 1 (k400) more better than variation 2 (k350). Degradation of variation 1 (k400) was 17,7% and variation 2 (k350) 19,8% after specimen burn, can be show at figure 5.

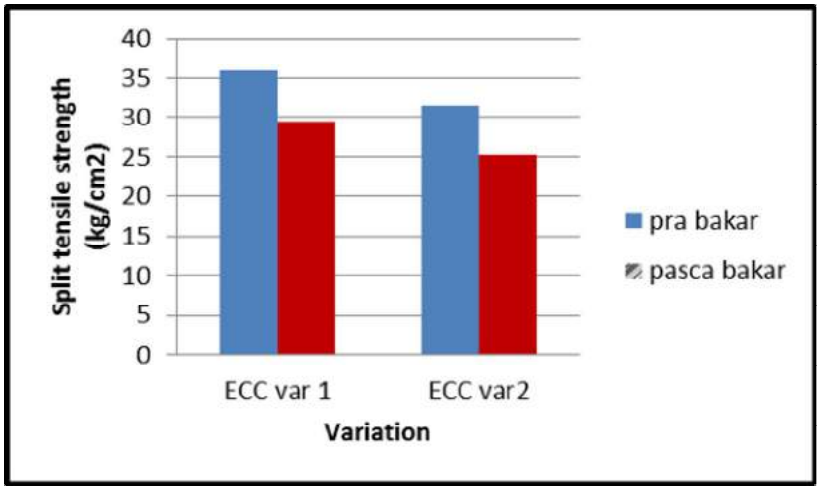

Figure 5. Split tensile strength

### 3.4. Modulus of Rupture (MOR)

Modulus of Rupture (MOR) experimental compare with MOR theoretical, the result show that experimental more lower than theoretical show figure 6

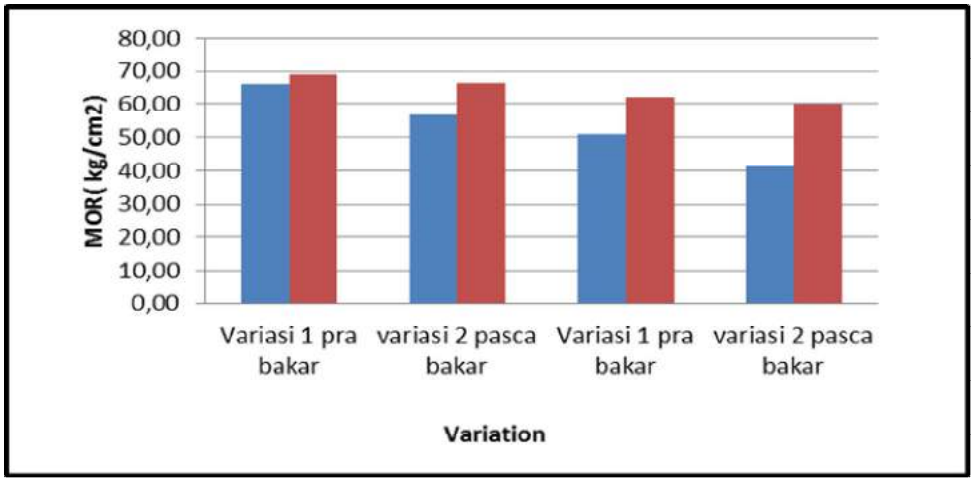

Figure 6. compare experimental MOR with theoretical MOR pre and post burn

### 3.5 Shear Strength Test

Shear strength of concrete based on Iosipescu test specimen, which uses the test object with a size of 6 x 15 x 35 cm. obtained the results as shown in the following figures 7. The result show Shear test in specimen post burn was degradation 46,51% for variation 1 (k400) and 60% for variation 2(k350).

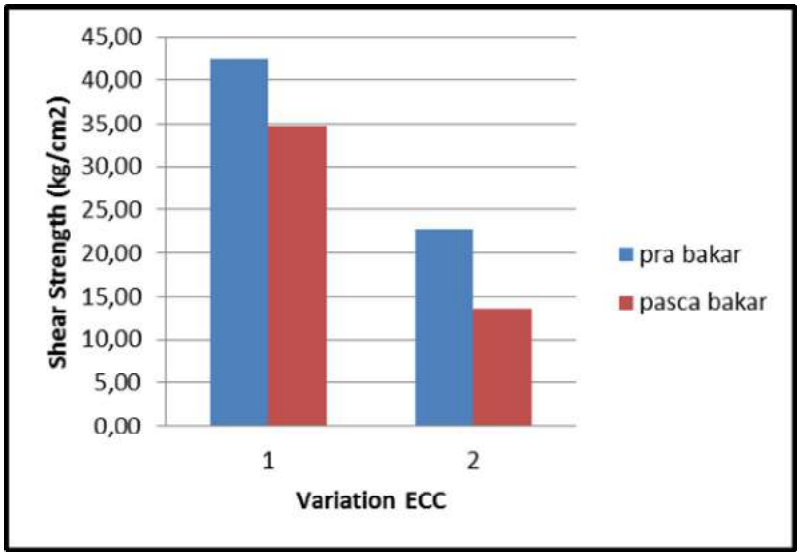

Figure 7. Shear Strength ECC

## 4. Conclusions

From the observations of experimental Engineered Cement composite material, The following conclusions could be drawn :

- Engineered cement composite Material (ECC) was degradation in compressive strength, MOR, and shear after burn
- Variation one (K400) decrease 19%, 23% and 45,61% for compressive strength, modulus of rupture and shear strength
- Variation two (K350) decrease 20%, 27,2% and 60% for compressive strength, modulus of rupture and shear strength.

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